

Cargo Compartment Fire Suppression Advisory Circular

Final Revision – 25.795 (b)(3)

1. Purpose: This advisory circular provides a means, but not the only means of compliance with § 25.795 (b)(3) and discusses the rulemaking action that implements the intent of ICAO Annex 8, Amendment 97 Standards, pertaining to airplane cargo-compartment design requirements. An applicant may propose an alternate means of compliance to the Administrator. This rule requires that the cargo compartment fire suppression systems, including their suppressing agents, must be designed so as to take into consideration a sudden and extensive fire, such as could be caused by an explosive or incendiary device. Based on the assumptions given in paragraph 5 of this AC, the only components of the system requiring special attention are the storage/activation/distribution components that are not installed in an area considered remote to the cargo compartment, due to their vulnerability to fragments and/or large deformations of supporting structure resulting from an explosive event.
2. Related FAR Sections: § 25.851(b), 25.855, 25.857, 25.858
3. Background: Existing cargo-compartment fire-protection systems are capable of several functions. The initial function is to detect a fire within a cargo compartment. Once a fire is detected, the system provides a warning to the flight crew compartment. The flight crew then activates the fire suppression system to discharge suppression agent to subdue the fire in the affected cargo compartment.

Past regulations required that the cargo fire-protection systems be capable of suppressing any fire likely to occur in a cargo compartment. However, the regulations did not require the cargo fire-protection systems to be capable of withstanding the effects of an explosive or incendiary device. This additional requirement is now included in §25.795 (b)(3) and requires that the cargo fire-protection system design consider those effects. Notwithstanding the basic assumptions, the follow-on discharge must be equally protected. The intent of this requirement is to protect the airplane from a fire resulting from the event (as defined in paragraph 4.a).

4. Definitions: For the purposes of this AC, the following are applicable:
 - a) Event. The activation of an explosive or incendiary device.
 - b) Suppression Agent. The substance, usually fluid or gas, discharged into the cargo compartment to suppress a fire.
 - c) Knockdown Discharge. The initial sudden application of suppression agent into the cargo compartment with the intent of extinguishing a fire in a cargo compartment.
 - d) Follow-on Discharge. Subsequent application of suppression agent into the cargo compartment with the intent of preventing the fire from rekindling if not extinguished after the knockdown discharge application of suppression agent.

- e) Storage Vessel. Component containing the suppression agent.
- f) Remote Installation. Isolation of a component from exposure to fragments and large deformations resulting from an event in the cargo compartment.

5. Assumptions: The following assumptions are included:

- a) Explosive and incendiary devices produce similar consequences.
- b) Activation of explosive and incendiary devices produce only surface fires. Based on several explosive tests conducted in luggage compartments by the FAA, deep-seated fires are extremely rare in explosive events.
- c) Existing cargo compartment liner requirements are assumed to be adequate. The reasons for this are:
 - 1) In the case of an event, the resultant fire is assumed to be a surface fire and the knockdown discharge system will extinguish such a fire even if the liner is breached.
 - 2) Cargo compartment liners are flame-penetration resistant per § 25.855(c).
- d) The cargo compartment fire detection system does not require explosive protection. The reasons for this are:
 - 1) If the event is small, there will be no effect on the fire detection system;
 - 2) If the event is large enough to affect the integrity of the fire detection system, the passengers or crew will notice the event. Then, if smoke or odors are present, the crew will know to discharge suppression agent to the affected area. In addition, the failure of the affected fire detection system must be annunciated to the crew for the specific compartment. As a result, no changes are required to make the fire detection systems resistant to one of these events.
- e) No additional suppression agent is required. Existing suppression agent requirements are sufficient per paragraph 5.c.1.
- f) Acceptable suppression agent. The ICAO standard recognizes that Halon suppression agents satisfy the intent of this requirement from the standpoint of suppression. However, Halon production has been banned because of environmental concerns as a chemical that contributes to depletion of the ozone layer. Although there are stores of Halon and its supply is not immediately a concern, Halon will not be available indefinitely. The FAA has been working with the International Halon Replacement Working Group (now the International Aircraft Systems Fire Protection Working Group) to establish minimum performance standards for new suppression agents that will provide capability "equivalent" to the existing Halon agents. These minimum performance standards will be published and adopted by the FAA as guidance for future agent approvals. Therefore, it is expected that this requirement will have no effect on the type of agents that will be used in the future.
- g) The pressure hull is not breached. This advisory circular assumes that the airplane pressure shell remains intact during one of these events even though some structural components within the airplane may fail or be damaged.
- h) Most components of the suppression system do not require protection against a pressure wave resulting from an event. The pressure wave from an event is assumed to act uniformly around the components, as observed from several experimental trials, and would not normally cause pressure damage to these components. However, any component that projects a surface area greater than four square feet (any single dimension greater than four

feet may be assumed to be only four feet in length) will require structural reinforcement to counter the inability of the pressure wave to uniformly propagate around large objects.

- i) The mechanisms that produce threatening damage are from large-scale deformations and fragmentation. An event can induce sizeable loads on large surfaces, causing components of the suppression system attached to these surfaces to deflect beyond safe limits and high-energy fragments can puncture distribution lines and storage devices.

6. Discussion: Cargo-compartment fire-protection systems generally contain a fire detection and fire suppression system. The normal system operation entails the fire detection system activating an alarm in the flight-crew compartment when fire is detected in a cargo compartment. The flight crew then activates the suppression system to discharge the suppression agent into the applicable cargo compartment.

The fire-detection system generally consists of fire detectors that sample air from a cargo compartment. When sufficient quantities of combustion byproducts enter a fire detector, the detector activates an alarm.

The cargo fire suppression systems generally consist of storage devices containing suppression agent, distribution tubing or piping, and associated hardware. When the suppression system is activated, an initial knockdown discharge of suppression agent is distributed to the cargo compartment. After the initial knockdown discharge, follow-on suppression agent is then distributed to the compartment either at a metered rate or as a discrete discharge.

When taking into consideration the effects of an explosive device on the cargo fire protection system, the assumptions in section 5 of this AC must be considered. As a result, the only part of the cargo fire protection system deemed necessary to be modified is the storage/activation/distribution system. Therefore, the proposed compliance methods will only address the storage/activation/distribution system and the types of damage that must be addressed are from fragmentation and large deformation of supporting structure.

Due to the damage that may result from an event, quantities of suppression agent, which may be considered toxic, may enter into compartments occupied by crew or passengers. However, the agent is considered to present less potential hazard than products of the fire itself.

7. Compliance: Compliance may be demonstrated by analysis and/or design review. An assessment of vulnerability for the storage/activation/distribution systems must be made.
 - a) Storage Devices and Activation. Storage devices and any electrical or mechanical devices that are attached to the storage devices for activation purposes would require protection. A general assessment of component vulnerability should include consideration of their location relative to a potential event, the arrangement of any feature (e.g., cargo compartment liner) between them and the event and their potential displacement from the features own displacement or deformation. There are at least three separate approaches that will satisfy compliance for the storage devices and their associated activation system.

- 1) Component Protection. Protect those components that are not installed in an area remote to a cargo compartment. Storage/activation devices or protective barriers that will withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second are acceptable. The ballistic resistance of 0.09-inch thick 2024-T3 aluminum offers an equivalent level of protection. Barriers with dimensions beyond those described in paragraph 5.h and their supporting structures designed to protect components must be able to tolerate a 15-psi static pressure load without deformation that would compromise the function of the system.
- 2) Remote installation. Install storage devices and/or their associated activation devices in an area that is remote from the cargo compartment. Items that are remote from the cargo compartment are considered acceptable without protection. Credit may be taken for any permanent barriers between the cargo compartment and the component that can be shown to offer fragment and or large deformation protection, as applicable. Barriers with dimensions beyond those of paragraph 5.h, and their supporting structures designed to isolate components and meet the remote criteria must be able to tolerate a 15-psi static pressure load in combination with any other loads applicable with their design without deformation that would compromise the function of the system. The fragment penetration requirements must also be met.
- 3) Provide redundancy. Redundant storage devices and their associated activation system components that are separated in accordance with §25.795(d) would be sufficient.
- b) Distribution System. Any of the following approaches separately or in combination are acceptable methods of compliance:
 - 1) Utilize redundant tubing. Redundant tubing systems that are separated in accordance with §25.795(d) would be sufficient. No additional measures would be necessary.
 - 2) Utilize tubing protection:
 - (i) Shielding. Shielding and or inherent protection of the tubing must be able to withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second, and;
 - (ii) Tubing and Tubing Supports. The tubing system design must incorporate features that minimize the risk of tubing rupture or failure due to displacement of the structure to which it is attached. This may include flexibility in both the tubing and/or its mountings. In the absence of test evidence or alleviating rationale, provisions should allow for a minimum 6-inch displacement in any direction from a single point force applied anywhere along the tubing due to support structure (e.g., floor beam or other equivalent structure) displacements or adjacent materials, such as cargo liners or cargo substances, displacing against the tubing from the event in the cargo compartment. Frangible attachments or other features that would preclude tube rupture or failure may also be incorporated.